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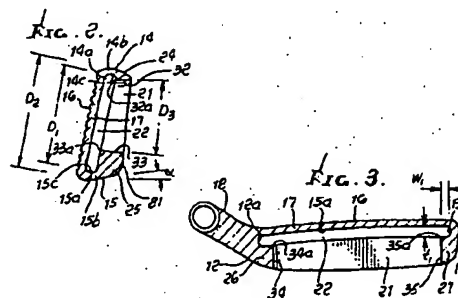
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⑤④ Iron golf club head with dual intersecting recesses.

⑤⑦ A golf club head (10) (e.g. an "iron" club head) has a body (11) defining a heel (12), toe (13), top wall (14), sole (15) and a front wall (17) defining an upwardly and rearwardly inclined front face (16) and rear face. The body has a forwardly extending main recess (21) located rearwardly of the front wall (17) and also an undercut recess (22) located directly rearwardly of the front wall rear face and extending outwardly from the main recess toward the top wall (14) and toward the bottom wall (16). The rear face of the front wall has a slant height dimension D_1 between uppermost and lowermost extents of the undercut recess (22) in a vertical plane, and the front wall (17) itself has a slant height dimension D_2 between uppermost and lowermost extents thereof in the plane, and $.90 < D_1/D_2 < .95$.



This invention relates generally to golf clubs, and more particularly to golf club irons of improved construction to achieve advantages, such as twist resistance, during impact with golf balls, and delayed momentum transfer to golf balls during stroking. In this regard, and in the past, irons evolved in design from flat back to hollow back structure, the present invention providing a further evolution in back structure to achieve virtual head enlargement effects.

Many efforts have been made to design iron heads to achieve higher energy availability for transfer to the golf ball when the ball is impacted by the head. However, no way was known, to our knowledge, to achieve delayed momentum transfer to the ball, over the very short time interval when the ball remains in contact with the head face, in the novel and unusual manner as achieved by the present invention; and no way was known to couple such delayed energy transfer with head twist resistance, in the manner to be described.

It is a major object of the invention to provide an improved iron head construction meeting the need for delayed momentum transfer to the ball during club stroking, and also to provide club head increased twist resistance. Basically, the invention as embodied in a head metallic body, is constructed to define two intersecting recesses rearwardly of the head front wall, and bounded by head metallic extents projecting rearwardly proximate peripheral regions of the head face defining front wall. For example, the head may include:

- a) a body defining a forwardly extending main recess located rearwardly of the front wall,
- b) and the body also defining an undercut recess located directly rearwardly of the front wall and extending outwardly from the main recess toward at least two of the following:
 - i) the top wall
 - ii) the bottom wall
 - iii) the toe
 - iv) the heel.

As will be seen, the undercut recess may extend outwardly from its intersection with the main recess toward all of the top and bottom walls, and the toe and heel, whereby the undercut recess may then bound the main recess. This construction facilitates slightly delayed forward transfer of momentum of the body metal rearwardly of the undercut recess, to the front wall and front face, via peripheral extents of the head. Typically, the metal of the head has reduced thickness directly rearwardly of the front wall periphery, due to the provision of the undercut recess, as referred to. This also enables reallocation of some metal to project rearwardly from the undercut recess, enhancing head peripheral weighting for anti-twist effect.

Another desire is to extend undercut the recess upwardly and downwardly into proximity with the up-

permost and lowermost extents of the head front face, and to redistribute head metal to project rearwardly of the undercuts, whereby a significant sweet spot enlarging effect is achieved. Lateral sweet spot enlargement is also provided by undercuts at the toe and heel.

Another desire is to provide an undercut recess, as referred to, which extends in a loop that lies generally parallel to the inclined front face of the iron. The inclination of that loop varies with the number of the iron, designating different front face inclinations, as for example 1 to 9 irons and wedges.

The head may be provided with a rearward projection with upward thickening between the bottom wall and the main recess, and rearwardly of the undercut recess that extends toward the bottom wall; and the head may also have a rearward projection with downward thickening between the top wall and the main recess, and rearwardly of the undercut recess that extends toward the top wall.

The invention further aims to provide a set of irons, each iron incorporating the dual intersecting recesses, as referred to, and the rearward projections extending generally horizontally irrespective of the angles of the front faces of the irons in the set.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a rear elevation of a #1 iron of a golf club set incorporating the invention;

Fig. 2 is a section taken on lines 2-2 of Fig. 1;

Fig. 3 is a section on lines 3-3 of Fig. 1;

Fig. 4 is a rear perspective view of the Fig. 1 head;

Fig. 5 is a view like Fig. 1 but showing a #6 iron incorporating the invention;

Fig. 6 is a vertical section taken on lines 6-6 of Fig. 5;

Fig. 7 is a section on lines 7-7 of Fig. 5;

Fig. 8 is a rear perspective view of the Fig. 5 head;

Fig. 9 is a view like Fig. 1 showing a #8 iron incorporating the invention;

Fig. 10 is a vertical section taken on lines 10-10 of Fig. 9;

Fig. 11 is a section taken on lines 11-11 of Fig. 9;

Fig. 12 is a rear perspective view of the Fig. 9 head;

Fig. 13 is a view like Fig. 1 showing the rear side of a pitching wedge incorporating the invention;

Fig. 14 is a vertical section taken on lines 14-14 of Fig. 13;

Fig. 15 is a section taken on lines 15-15 of Fig. 13;

Fig. 16 is a rear perspective view of the Fig. 13 head; and

Fig. 17 is a view like Fig. 1 showing corner slots.

Referring first to Fig. 1, the illustrated golf club head 10, in the form of a #1 iron of a set, has a body 11 defining a heel 12, to 13, top wall 14, and bottom wall or sole 15. The body also defines an upwardly

and rearwardly inclined front face 16 at the frontal side of an associated front wall 17. A hosel is shown at 18 and integrally joins the body via neck 20; and a shaft 19 extends into a bore 19a that extends through the hosel as seen at bottom bore opening 19b, and is anchored therein in a suitable manner. Opening 19b may be suitably plugged. The head and hosel may consist of a one-piece, metallic, steel casting, other metals and alloys being usable.

In accordance with the invention, the body defines two intersecting recesses related to rearwardly elongated body projections, typically-extending rearwardly, as will be described, irrespective of the head front face angularity. The two recesses include a forwardly and rearwardly extending main recess 21, and an undercut recess 22 located directly rearwardly of the front wall and extending laterally outwardly from the forwardmost extent of the main recess 21, toward at least two of the following:

- i) top wall 14
- ii) bottom wall or sole 15
- iii) the toe region 13.
- iv) the heel region 12.

Typically, the undercut recess portions 14a and 15a, associated with walls 14 and 15, are elongated directionally between the toe and heel, over the major length of the head, thereby achieving a large portion of the benefits of the invention. These benefits include metal redistribution toward the upper and lower peripheries of the head, and projecting rearwardly at 24 and 25, for enhancing anti-twist of the head during stroking and ball impact. Such metal rearward redistribution, i.e., lengthening in a rearwardly direction, as at 24 and 25, rearwardly of undercuts 14a and 15a, is believed to achieve somewhat delayed momentum transfer from the metal portions 24 and 25, to the front wall and front face 16, thereby maintaining a greater time interval of front face contact with the ball during stroking, for better ball control. The size and mass of the lower projection 25 substantially exceeds the size and mass of the upper projection 24, as is seen in Fig. 2, enhancing the delay effect.

Note that such momentum transfer, visualized in the form of forward waves, is required to pass around and through the reduced thickness forward portions 14b and 15b of the rearwardly projecting portions 24 and 25, enhancing such delay. Such delay of wave travel through narrowed regions (or webs or bridges) 14b and 15b is facilitated by the outwardly concave curvature at 14c and 15c, or other similar thickness narrowing shape, bounding the outermost extents of the undercuts 14a and 15a. Enhanced performance and ball control have been determined by repeated actual use of such an iron, both with humans and robots. A sweet spot enlarging effect (vertically) is achieved without requiring head vertical enlargement. Note that the undercuts 14a and 15a are near the uppermost and lowermost extents of face 16, and the

slant height dimension D_1 of the undercut recess is 90% to 95% of the slant height D_2 of face 16. Thus, $.90 < D_1/D_2 < .95$.

The undercut recess portions 12a and 13a, associated with the heel and toe, and associated metal redistribution rearwardly and functionally outwardly (i.e., enlarging effect) from those undercuts, contribute to and add to the same effects as described above for the undercut recess portions 14a and 15a, i.e., the sweet spot is enlarged toward the toe and heel. The undercut recess projects outwardly at 12a, 14a, and 15a at the heel, toe and toward the top walls, respectively, i.e., from the edges 34a, 35a, and 32a, to an extent w_1 (which may vary, as shown); however, the front-to-rear thickness t_1 of the undercut recess is approximately as follows:

$$.5t_1 < w_1 < 1.5t_1$$

Note that the undercut recess at 15a projects downwardly from edge 33a to an extent between 1.5 and 2.5 times w_1 .

The radii of the circular curvatures at 14c and 15c are typically between .150 and .160 inches for #1 through #7 irons; between .210 and .230 for #8 and #9 irons; and between .300 and .320 for a pitching wedge; however, these dimensions can vary.

Note in this regard the rearward projections 26 and 27 in Fig. 3, extending rearwardly from the undercuts 12a and 13a, and also rearward projections at 24 and 25. Such rearward projections 24 and 25, 26 and 27, are elongated directly rearwardly of the undercuts 12a, 13a, 14a, and 15a, and in relation to their thickness dimensions, showing that metal has been redistributed to those projections to enhance the effects described and without increasing the overall vertical dimension of the head.

The inner sides or ledges 32 and 33 defined by the projections 24 and 25 are substantially flat in a forward-to-rearward direction; however, they define a loop in combination with the corresponding inner and curved sides 34 and 35 of the projections 26 and 27, that loop subtending the major aerial extent of the front face, including an enlarged "sweet spot". Correspondingly, all undercut recess portions 12a, 13a, 14a, and 15a, also define, preferably, a loop. Undercut recess concave corners appear at 50, 51, 52, and 53. Dimension D_3 between 32 and 33 is substantially less than D_1 at all sections parallel to the section of Fig. 2. The undercut recess has a periphery defining an area A_1 within that periphery, the front face 16 having a maximum area, where

$$.90 < A_1/A_2 < .95$$

It is found that the undercut recess structure substantially enlarges the effective sweet spot, at the face 16. Side 32 is inclined upwardly and rearwardly from horizontal at between 1° and 3° ; and side 33 is inclined downwardly and rearwardly from horizontal at between 1° and 3° . Bottom wall 15 is inclined at α upwardly and rearwardly from horizontal at between

5° and 8°. A local relief facet 80 (inclined upwardly and rearwardly) is provided beneath the sweet spot location to intersect bottom wall 15 and rear surface 81.

Fig. 17 shows that slots may be provided, as at 40-43, proximate corners of the loop defined by the rearward projections 24-27 to decouple or reduce the stiffening effect of joining the rearward extending portions 24-27 at the loop corners. This allows the momentum transfer from each of such portions to independently proceed forwardly, with delayed action, as referred to, without being affected by the momentum transfer associated with the other portions, or attenuated by the effects of such other portions.

Figs. 5-8 show a corresponding construction of a #6 iron, having a more inclined front face, as shown. The corresponding numbered elements are the same as those in Figs. 1-4, with each number preceded by a 1, i.e., providing a one hundred series of numbers.

Figs. 9-12 correspond to Figs. 1-4, but show a #8 iron with the two intersecting recesses in associated structure, as defined above. The corresponding elements have a 2 preceding each number, whereby a two hundred series of elements is defined.

Figs. 13-16 correspond to Figs. 1-4, but show a pitching wedge with the two recesses in associated structure, as defined above. The corresponding elements have a 3 preceding each number, whereby a three hundred series of elements is defined.

It will be understood that intermediate irons have the same construction, but with associated changing front face inclinations, as in a set of such irons. Accordingly, each iron of the set has the invention incorporated therein.

Claims

1. A golf club head (10, 110, 210, 310), e.g. an "iron" club head, having a body (11) defining a heel (12), toe (13), top wall (14), sole (15), and a front wall (17), defining an upwardly and rearwardly inclined front face (16), and rear face, wherein
 - a) said body (11) defines a forwardly extending main recess (21) located rearwardly of said front wall (17),
 - b) said body (11) also defines an undercut recess (22) located directly rearwardly of said front wall rear face and extending outwardly from said main recess (21) toward said top wall (14) and toward said bottom wall (15), adjacent said rear face, said rear face having a slant height dimension D_1 between uppermost and lowermost extents of said undercut recess (22) in a vertical plane, and said front wall (17) having a slant height dimensions D_2 between uppermost and lowermost extents thereof in said plane, where: $.90 < D_1/D_2 < .95$;

the body for example being metallic, for instance a metallic casting which may be a one-piece casting.

2. The golf club head of claim 1 wherein said undercut recess (22) also extends outwardly from said main recess (21) and adjacent said front wall rear face towards said toe (13), and optionally the undercut recess extends outwardly from said main recess and adjacent said front wall rear face toward said heel (12), said undercut recess having a periphery defining an area A_1 within said periphery, and said front face having a maximum area A_2 , where $.90 < A_1/A_2 < .95$.
3. The golf club head of claim 1 wherein said top wall (14) and bottom wall (15) have substantially reduced thickness outwardly of said undercut recess (22), which for example extends in a loop that is generally parallel to the inclined front face (16).
4. The golf club head of claim 1 wherein said head has rearward projection (25) with upward thickening between said bottom wall (15) and said main recess (21), and rearwardly of said undercut recess (21) that extends toward said bottom wall (15), said undercut recess that extends toward said bottom wall having forward and rearward sides that extend parallel to one another; and/or the said head has rearward projection (24) with downward thickening between said top wall (14) and said main recess (21), and rearwardly of said undercut recess (21) that extends toward said top wall (14); said undercut recess that extends toward said top wall having forward and rearward sides that extend parallel to one another.
5. The golf club head of claim 1 wherein said undercut recess (22) projects outwardly to an extent w_1 , and has front to rear thickness t_1 , where $.5t_1 < w_1 < 1.5t_1$.
6. The golf club head of claim 4 wherein said rearward projection (25) having upward and/or downward thickening from the undercut recess (22) has substantially greater overall rearward dimension than vertical thickness dimension.
7. The golf club head of claim 1 wherein said body has at least one slit (40-43) extending rearwardly from said undercut recess (22) and extending outwardly from said main recess (22), for example at the following locations:
 - proximate the junction of the heel and top wall
 - proximate the junction of the heel and bottom wall

- proximate the junction of the toe and top wall
 - proximate the junction of the toe and bottom wall
8. The golf club head of claim 3 wherein said undercut recess (22) extends outwardly toward said top wall (14) and toward said bottom wall (15), the depth of the undercut recess toward said top wall being less than the depth of said undercut recess toward said bottom wall; and for example the undercut recess portion that extends toward said top wall (14) has a substantially semi-circular cross section adjacent said top wall, and the undercut recess portion that extends toward said bottom wall (15) has a substantially semi-circular cross section adjacent said bottom wall.
9. The golf club head of claim 8 wherein said undercut recess (22) proximate said heel (12) and proximate the toe (13) decreases gradually in depth in an upward direction.
10. A golf club head (10, 110, 210, 310), having a body (11) defining a heel (12), toe (13), top wall (14), sole (15) and a front wall (17) defining an upwardly and rearwardly inclined front face (16), wherein:
- a) said body defines a forwardly extending main recess (21) located rearwardly of said front wall (17),
 - b) said body also defines an undercut recess (22) located directly rearwardly of said front wall (17) and extending outwardly from said main recess (21) toward the following:
 - i) said top wall (14)
 - ii) said bottom wall (15),
 - said undercut recess (22) proximate said top wall (14) having lesser depth than said undercut recess proximate said bottom wall (15), and
 - c) said undercut recess (21) has uppermost and lowermost extents (14a, 15a) defining a separation distance D_1 and the front face (16) has uppermost and lowermost extents defining a separation distance D_2 , where $.90 < D_1/D_2 < .95$.
11. The golf club head of claim 10 wherein said top wall (14) has minimum thickness proximate said undercut recess (14a) extending toward the top wall, said bottom wall (15) has minimum thickness proximate said undercut recess (15a) extending toward said bottom wall, and said two minimum thickness s are approximately equal, and for example are between .075 and .085 inches (1.9 to 2.2 mm).
12. Multiple golf club heads (10, 110, 210, 310) in a set, each head having a body (11) defining a heel (12), toe (13), top wall (14), sole (15) and a front wall (17) defining an upwardly and rearwardly inclined front face (16), wherein
- a) said body defines a forwardly extending main recess (21) located rearwardly of said front wall (17),
 - b) said body also defines an undercut recess (22) located directly rearwardly of said front wall (17) and extending outwardly from said main recess (21) toward at least three of the following:
 - i) said top wall (14)
 - ii) said bottom wall (15)
 - iii) said toe (13)
 - iv) said heel (12)
 - c) the undercut recesses (21) in said bodies of the set have increasing rearward angularity in correspondence to increasing rearward angularity of the inclined front faces (16) of the bodies of the set, and
 - d) the undercut recesses (22) in each body of the set have parallel forward and rearward walls.
13. The multiple heads of claim 12 wherein in each of said bodies (10, 110, 210, 310), the undercut recess (22) projects toward the top wall (14) and toward the bottom wall (15) as defined, the undercut recess projecting toward the top wall (14) having a lesser depth than the undercut recess projecting toward the bottom wall (15).
14. The golf club head of claim 1, including slots (40-43) formed in corners defined by said head and intersecting said undercut recess (22); for example there are four of said slots, two of which (41, 43) are proximate the toe (13), and two of which (40, 42) are proximate a juncture defined by a hosel (18) and the remainder of the head.
15. A golf club head (10, 110, 210, 310) having a body (11) defining a heel (12), toe (13), top wall (14), bottom wall (15), a sole, and a front wall (17) defining an upwardly and rearwardly inclined front face (16), wherein
- a) said body defines a forwardly extending main recess (21) located rearwardly of said front wall (17),
 - b) said body also defines an undercut recess (22) located directly rearwardly of said front wall (17) and extending outwardly from said main recess (21) toward at least said top wall (14) and said bottom wall (15),
 - c) each of said top and bottom walls (14, 15) has a maximum vertical thickness region rearwardly of and adjacent said undercut re-

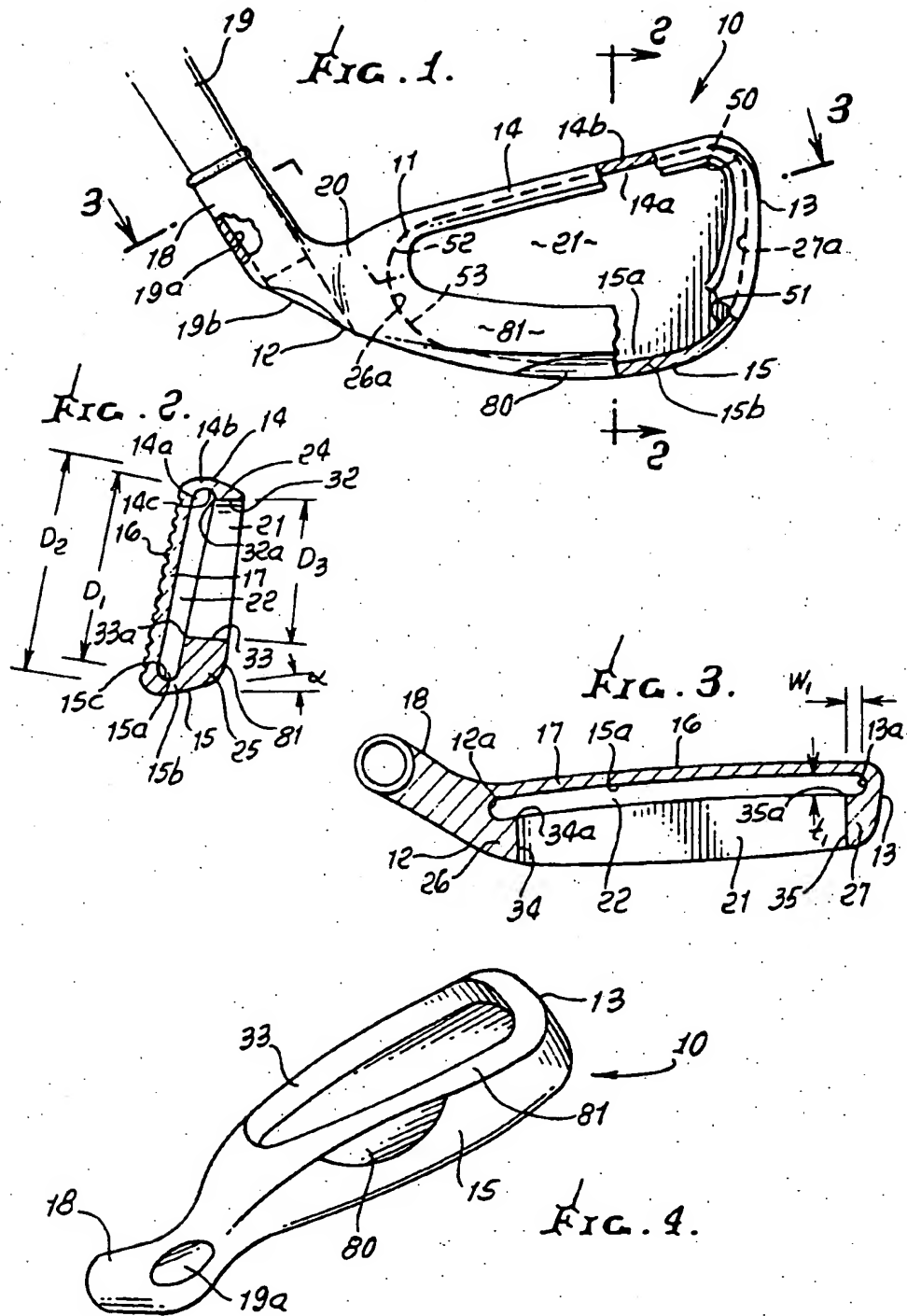
cess, said top wall (14) tapers rearwardly and is rearwardly elongated rearwardly of said undercut recess (22) to overlie said main recess, and said bottom wall (15) tapers rearwardly and is rearwardly elongated rearwardly of said undercut recess (22) to underlie said main recess, said top wall defines a reduced thickness web adjacent to and above said undercut recess, which is located rearwardly of the uppermost level of said front face, and said undercut recess nearest said web extending upwardly to a level proximate said uppermost level of said front face,

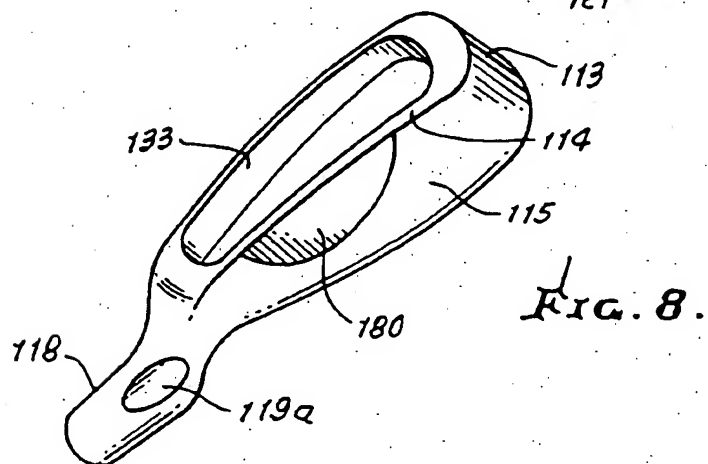
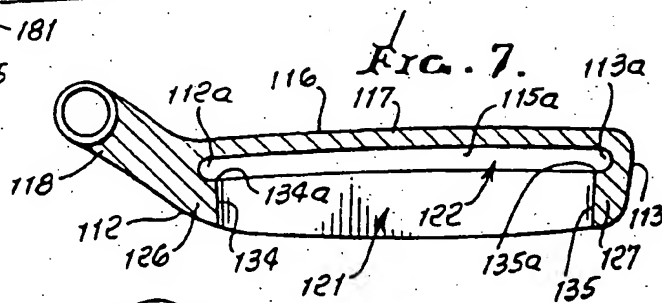
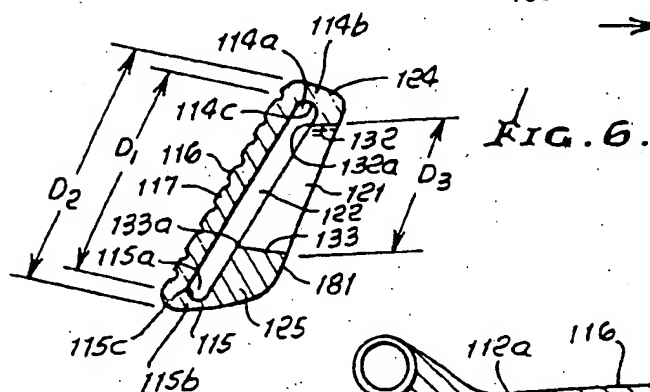
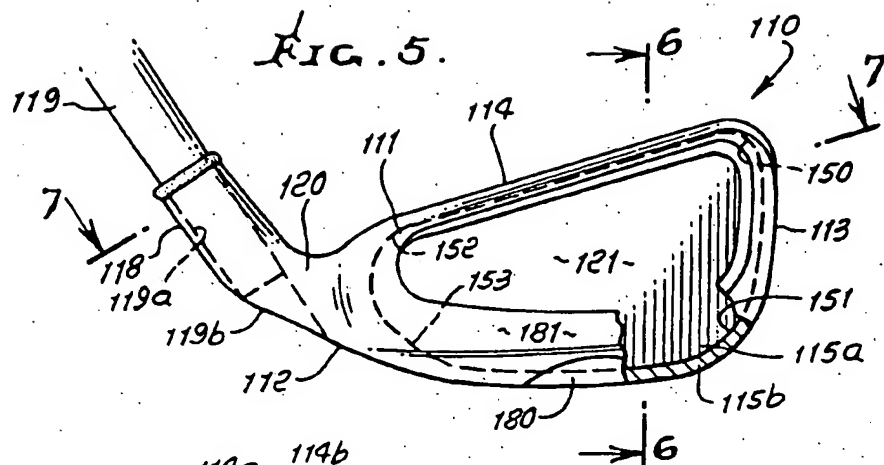
d) said rear face having a slant height dimension of D_1 between uppermost and lowermost extents of said undercut recess (22) in a vertical plane, and said front wall having a slant height dimension D_2 between uppermost and lowermost extents thereof in said plane, where: $.90 < D_1/D_2 < .95$.

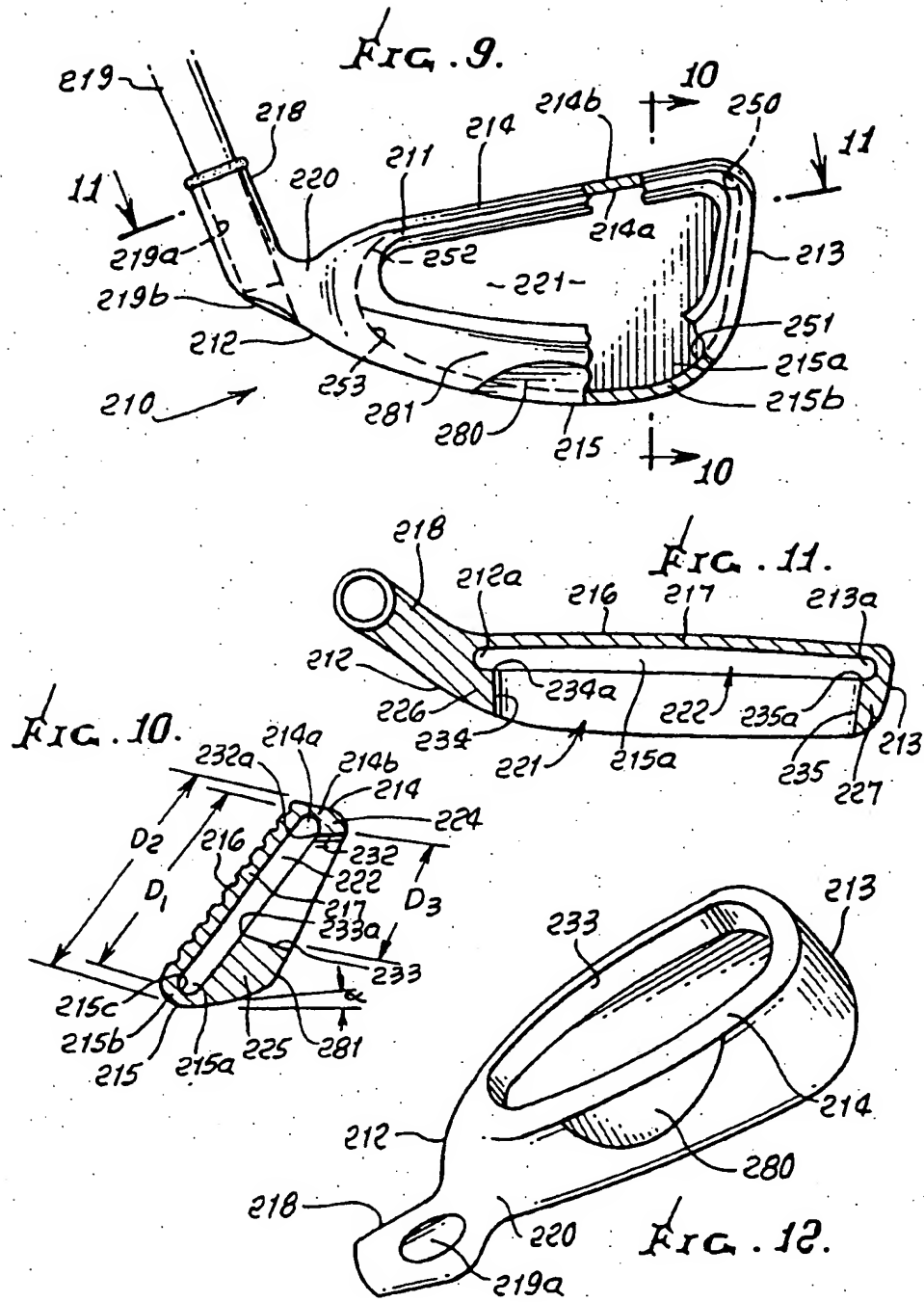
16. The head of claim 1 wherein said main recess (21), proximate said undercut recess (22), has a slant height dimension D_3 in said vertical plane, where

$$D_3 < D_1 < D_2,$$

and optionally the head has a rearward projection with upper thickening defining a top ledge, and a rearward projection with downward thickening defining a bottom ledge, said ledges having relative forward taper toward their intersection with said undercut recess (22).







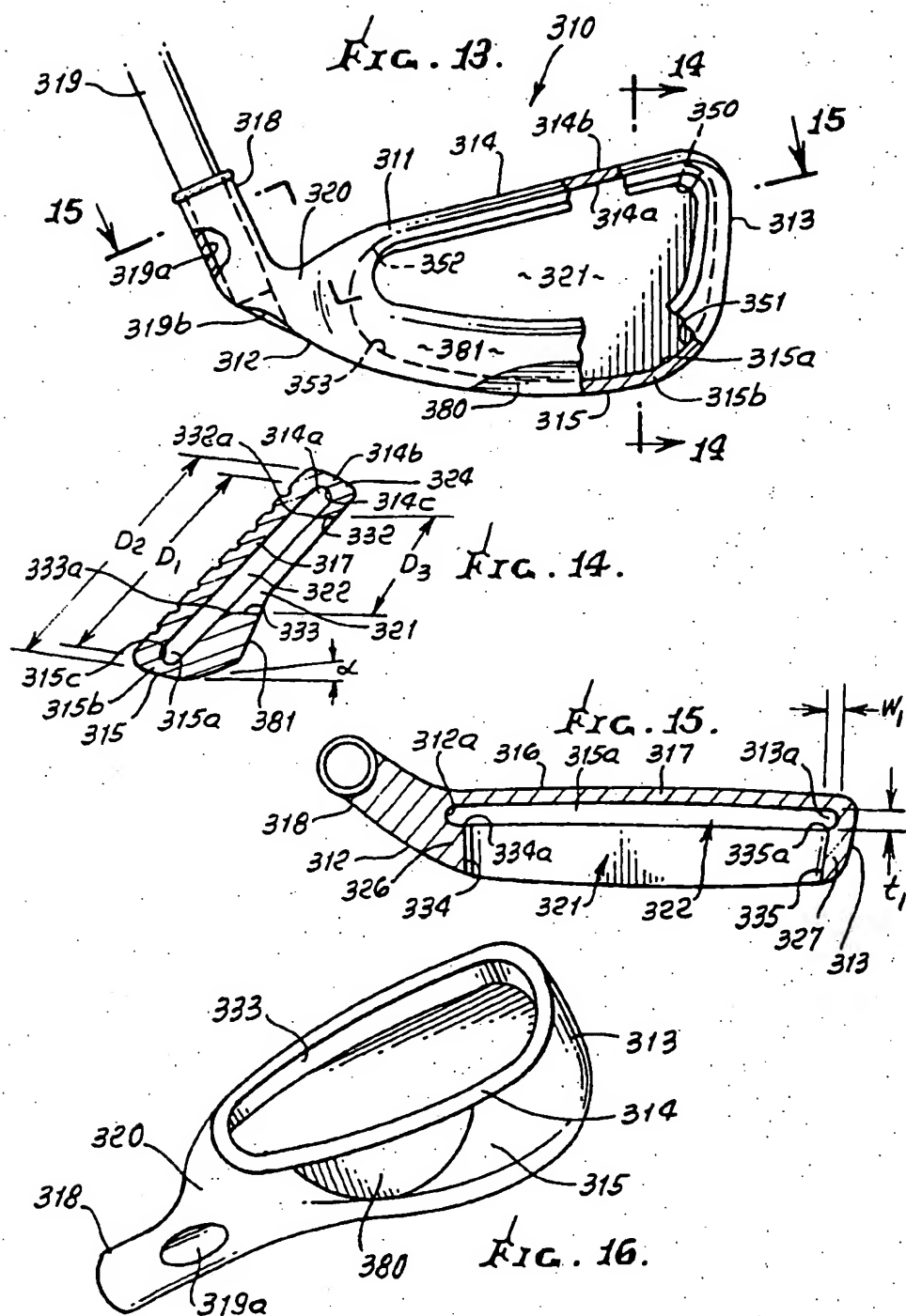


FIG. 17.

